3. I own a big casuarina plantation in Biridi. It has a length of nearly six miles. It is my idea to include it in the forests and to have the above sections of the Forest Act extended to it. I request to be favoured with your views and those of the District Forest Officer about this.

4. On a similar application for the extension of the Forest Act to my forests in the Vizagapatam district, the Government has, at the instance of the Collector, Vizagapatam, issued Notification No. 11, dated10th January 1924 (published in the *Fort St. George Gazette* of the 15th January 1924, page 67), and has issued rules in Notification No. 12 to regulate the management of the forest and waste lands in the Bobbili estate, Vizagapatam district. I have the honour to request that you will be good enough to similarly address the Government and get this my application in respect of the Biridi estate sanctioned.

APPENDIX X.

[Vide item II (ii) Communications to the Council on page 355 supra.]

REPORT AND RECOMMENDATIONS ON THE HYDRO-ELECTRIC POWER SUPPLY IN THE MADRAS PRESIDENCY BY Mr. S. G. FORBES.

GENERAL.

The Madras Presidency has no coal and its other fuel is in limited quantities and long distances from its industrial centres, or rather its centres that should be much more highly industrialized than they are at present. The price of wood-fuel in some parts of the Presidency is about Rs. 15 to Rs. 17 per ton and this has necessitated the bringing of coal long distances, at a cost of Rs. 28 to Rs. 30 per ton. This explains the backwardness of the Presidency in its industrial development, even though there is a great deal of water power, going to waste, within easy reach of all the centres which ought to be highly developed industrially.

2. It is a well-known economic fact that no country or province can secure its maximum growth of wealth and population by agriculture alone. A purely industrial country is usually wealthier and better developed than a purely agricultural country even though it has to import practically all its food and clothing.

3. If a country has no coal, then it must look to its water power resources and jealously retain such as it has for the use of its people in the broadest sense. That is, by Government's ownership. Wherever there is a water power, it is the duty of a Government to develop it and release the fuel consumed by the existing industries and permit the extension of industries to meet the needs of the people without further encroaching on the already depleted fuel resources of the world. By the use of hydro-power, fuel is released and cheapened for domestic purposes and industries which inherently require their power in the form of heat.

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4. Hydro-power is generally situated long distances from industrial centres, but fortunately, the electric generator, in unlimited sizes, readily lends itself, with a high degree of efficiency and flexibility to the water-turbine drive. Electricity is the most adaptable form of energy, which combined with the stage reached in the design and manufacture of generators, high-voltage transformers, switchgear, transmission line materials and motors, permits power in any quantity to be economically generated and transmitted long distances to industrial centres and there distributed in large or small blocks for lighting, heating and power purposes. That is, the 'liquid coal' flowing in our rivers and streams can be made to doubly serve man, by the generation of power for his industrial purposes, and still be used for irrigation after passing through the water turbines.

5. A cubic foot of water flowing for one year will produce from irrigation a revenue of Rs. 500, but if used first for the generation of power, may produce Rs. 5,000 and still be as good as before for irrigation. One cubic foot of water may earn a direct return of as much as Rs. 50,000 per annum when used for the generation of electric power. Here in Madras, there are water-power sites where a flow of one cubic foot per year will earn more than Rs. 40,000 per annum.

6. In meeting the industrial requirements for power with hydro-power a great deal of railway rolling stock engaged in the transport of coal is released for other purposes and the congestion on the railways is relieved. When there is a plentiful supply of Government hydro-electric power available at reasonable rates, the mill-owner is relieved of all anxiety, as he is not dependent on the vicissitudes of railway transport, miners' strikes and other factors that enter into a fuel supply from long distances. Those contemplating new industries will find the cost of the electric drive much cheaper than any other form and that no special arrangements for stocks of fuel have to be made. The electric power is there all the time with little preparation on the part of the consumer.

7. These factors greatly stimulate the growth of industries and in some localities only a hydro-electric power supply will make it possible to develop industries. I attribute the industrial situation in the Madras Presidency to the lack of an adequate hydro-electric power supply.

8. My recommendations are—

That the Government of Madras should develop, according to a regular programme to be worked out, its water-power projects, transmit the power to the consuming centres and sell it to the

ultimate consumer, large and small, wherever there are no existing licensed suppliers, and wherever such licences exist, force them to take the hydro-electric power in bulk:

That no more concessions be granted for the development of any of the water-power projects in the Presidency, and in the case of those concessions already granted no extension of the time-limits be made or any deviation from the terms already imposed be allowed. If the strict letter of the terms and conditions under which the concessions have been granted are deviated from, the concessions should be cancelled and the rights lapse back to Government:

That every effort should be made to induce all concession holders to cancel their concessions and the rights reverted to Government.

These recommendations apply also to the licences granted for the supply of electric power in any consuming centre in the Presidency.

9. My recommendations are based, among other considerations, on the fact that the water-power resources of a country belong to the people of that country, who are entitled to the fullest benefits to be derived from their development. Hydro-electric developments are, in nearly every case, highly profitable undertakings and the development of a country should benefit by this profit, using the surplus revenues for the reduction of taxation or the development of the country.

10. I do not mean that the power should be sold at actual cost of production, for then the consumer only would benefit, but the power should be sold for what it is worth to the consumer and the profit used for extending the hydro-electric system and in the construction of protective works, or to augment the general revenues of the Government. It is for this profit that private capitalists are anxious to take up and develop these power sites and exploit the power consumer.

11. In some cases, the development of a power site involves diverting the water from one stream into another. As there is irrigation under practically every stream in the Presidency, prescriptive rights will be affected which can be dealt with, only by Government. In most cases, the power sites are long distances from the consuming centres, and Government, as the owner of the transmission lines, can best deal with the question of rights of way. If the systems are Government-owned, then lands and sites can be acquired by Government for public purposes.

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12. It is sometimes said that Government cannot operate a commercial undertaking as economically as private businessmen can, but the above are some factors entering into a Government-owned hydro-electric power system which make it possible for Government to operate the system more economically than private businessmen could. This is especially true, if the system is treated as a purely commercial department of Government operated on commercial lines, using a commercial system of accounts and managed by experienced commercial hydro-electric power supply engineers.

13. Furthermore, if the hydro-electric power supply is Government-owned and operated, it will be much easier to have the laws regulating the supply of electric power amended and changed whenever necessary.

14. There are several Government-owned hydro-electric power systems in the world which are operated at great profit and benefit to the people of those countries. The province of Ontario, Canada, has its Hydro-electric Power Commission with one of the largest power systems in the world, and nearer Home, Mysore has its power system which works at a great profit and is a source of considerable revenue to the general funds of the State.

15. What has and is being done elsewhere can be done by Madras provided :

(1) There are water-power resources to be developed, and
(2) There will be sufficient consumers to make the undertaking profitable.

In considering such a proposal as this, due consideration must be given to the indirect returns to Government, in the form of increased taxes, more employment of the working classes, protection against famine and other factors of improvement in the economic conditions of the community.

Water-power Resources.

16. The water-power resources of the Presidency have already been examined to such an extent as will give a very good idea of what is available within reach of industrial centres. The known power sites are capable of generating considerably more power than will be required for a long time.

17. When the power sites, that have been more or less examined, are located on a map of the Presidency and considered with reference to the consuming centres, they fall into four divisions—

(1) The Southern division.
(2) The Madras-Nilgiri division.

(3) The Northern division.
(4) The West Coast division.

18. These divisions may have to be considerably modified after further and more complete examination of the power-consuming capacity of the Presidency. However, as there is so much territory to be covered, it would be ill-advised to delay making a start with the actual production and distribution of hydro-power until the whole Presidency has been completely surveyed for determining the amount of power which can be produced and the amount that can be consumed in the different divisions. The power systems in each of the divisions can, when necessary, be interconnected and made into one great net work of power transmission and distribution with an improved efficiency and economy of operation.

19. I would, therefore, recommend that three projects should be worked up in detail, one in the Southern division, one in the Madras-Nilgiri division and one in the Northern division. When these projects are worked up, it could be decided if all three, or only one, should be proceeded with.

Southern Division.

20. There are several power sites in the Southern division which could be developed for the supply of power to Madura, Trichinopoly, Tinnevelly and other intermediate towns. The transmission lines would be relatively short and the capital cost would be correspondingly lower.

21. In this division, there are the following power sites, among others (please refer to the map for the location of the numbers) :—

		Continuous power.	At 40 per cent load factor.
No. 106. The Periyar project—			
Head ... 991 feet.			
Flow ... 250 cusecs.			
$\frac{991 \times 62{\cdot}03 \times 250 \times 80\,\%\ \text{Eff.}}{550}$	...	22,000	55,000
No. 107. The Papanasanam project—			
Head ... 330 feet Flow ... 300 cusecs	...	9,000	22,500
No. 102. The Parappar project—			
Head ... 1,500 feet Flow ... 44 cusecs	...	6,000	15,000
No. 104. The Pinjikavi project—			
Head ... 5,000 feet Flow ... 22 cusecs	...	10,000	25,000
Total	...	47,000	117,500

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22. The use of the Periyar Project, No. 106, for the generation of electric power will affect certain irrigation rights which can, without doubt, be satisfactorily settled if the project is developed by Government. If any compensation is paid on this account, it should be in the form of a block of power, which will stimulate the development of industries in that district more than if a money compensation is paid.

23. There are several other projects in this division, but these four show that there is ample power available with which to make a start and further investigations will show what can be made available in the future as the demand arises and the consumption of power passes beyond their combined capacity.

24. The first project with which a start could be made will, on examination, probably be No. 106, the Periyar, and the others developed as the need arises.

The Madras-Nilgiris Division.

25. This is naturally the most important division; it will consume more power and contains many good projects capable of meeting all demands for a long time. Among these projects, the following four may be mentioned as being suitable for the supply of power to Madras and intermediate points :—

		Continuous power.	At 40 % load factor.
No. 115. The Pykara Project—			
Head	3,250 feet.		
Catchment area	43 sq. miles.		
Average rainfall	80 inches.		
Minimum rain may be taken at 60″ (A.R.F. has been less than 60″, four times in 27 years.)			
Run off at 50 per cent	3,000 m.c.ft.		
Allow 10 per cent seepage and evaporation.			
Cusec $= \frac{3,000 \times 90\ \%}{8,760 \times 3,600} = 85$ cusecs.			
E.H.P. $= \frac{85 \times 62{\cdot}3 \times 3,250 \times 80\ \%\ \text{Eff.}}{550} =$		25,000	63,000
No. 116. The Cholatipuza Project—			
Head	2,250 feet.		
Catchment area	75 sq. miles		
Minimum rainfall 90″	7·5 feet.		
Run off factor	50 per cent.		
Seepage, etc.	10 per cent.		
Run off	7,100 m.c.ft.		
Cusecs $= \frac{7,100\ \text{m.c.ft.}}{8,760 \times 3,500} = 222$ cusecs.			

	Continuous power.	At 40 % load factor.
No. 116. The Cholatipuza Project—*cont.* (The stream flow is such that very little storage would be required for a flow of 100 cusecs.) E.H.P. = $\frac{200 \times 62{\cdot}3 \times 2{,}250 \times 80\ \%\ \text{Eff.}}{550}$ = ...	41,000	102,500
No. 113. The Upper Bhavani Project—		
Head ... ... 1,350 feet.		
Catchment area ... ... 91 sq. miles.		
Rainfall ... ... 65 inches.		
Run off ... ... 6,200 m.c.ft.		
Flow ... ... 196 cusecs.		
(Here the stream flow is good and a small amount of storage will give 100 cusecs continuous flow.)		
Use 190 cusecs. E.H.P. = $\frac{190 \times 62{\cdot}3 \times 1{,}350 \times 80\ \%\ \text{Eff.}}{550}$ = ...	23,200	58,000
No. 118. The Silent Valley Project—		
Head ... ... 2,200 feet.		
Catchment area ... ... 26 sq. miles.		
Rainfall ... ... 50 inches.		
Run off ... ... 1,450 m.c.ft.		
Flow ... ... 42 cusecs.		
If all the above run off is stored and used up for power, then— E.H.P. = $\frac{42 \times 62{\cdot}3 \times 2{,}200 \times 80\ \%\ \text{Eff.}}{550}$ = ...	8,350	20,800
Total ...	97,550	244,300

26. In the Madras-Nilgiri division, the easiest and cheapest to develop is the Pykara project. It will not require any extensive headworks and there is a very fine site for a storage reservoir. There will be no tunnelling and the site of the penstocks is almost ideal. It is, however, about 60 miles from a railway and all bridges, etc., on the road from the Mysore frontier to the power station will have to be strengthened or rebuilt. The Pykara project is about 30 miles nearer to Madras than the Cholatipuzha project and as the transmission line costs approximately Rs. 40,000 per mile, this means a saving of about Rs. 12 lakhs in the first cost as compared with the Cholatipuzha project.

27. However, this 30 miles of line will have to be constructed when the power demands exceed the capacity of Pykara and also if and as soon as there is any considerable railway electrification. I would here point out that it is one of the essential requirements of railway electrification that the power supply therefor be derived from more than one power station. No important railway should depend on only one source of power supply.

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28. A comparison between these two is made on the basis of the information available, which is very small so far as Cholatipuzha is concerned, but I have already examined Pykara on the ground and consider it an almost ideal project. I therefore consider Pykara as the project with which to make a start as it will be able to meet the first three or four years' demands. Cholatipuzha should be the next and Nos. 113 and 118 later on when required.

The Northern Division.

29. There are several good power sites in this division, but the information is not complete, nor is there much information available as to the probable consumption.

		Continuous power.	At 40 % load factor.
No. 2 Kolab Project—			
Head	770 feet	56,000	140,000
Flow	800 cusecs		
There is another project in this locality 30 miles from Vizagapatam, the name of which is the Anantagiri project.*			
Head	800 feet	4,600	11,300
Flow	63 cusecs		
Total ...		60,600	151,300

* This project could be executed at a cost of Rs. 58 lakhs including generation, transmission and the distribution of the power in Vizianagram and Vizagapatam, where there is already a considerable demand for power which will be largely augmented by reason of the harbour works at the latter place. I examined this project in 1922.

The West Coast Division.

30. I have not examined the information on any of the projects in this division, but there is a project in Cochin State on the Chalakadi river which I examined in detail in 1918 and found a head of 577 feet, and water for storage sufficient to give a continuous flow in the channels of 500 cusecs. The E.H.P. obtainable at this site would therefore be—

$$\text{E.H.P.} = \frac{500 \times 62{\cdot}3 \times 577 \times 80\,\%\ \text{Eff.}}{550} = 26{,}000$$

or at a 40 per cent load factor = 65,000 E.H.P.

31. The cost of this project was estimated in 1918 at Rs. 40 lakhs for the supply of about 6,000 horse power to Ernakulam and Trichur, and would yield a revenue which would pay all operating and maintenance costs plus 4 per cent depreciation, plus 6 per cent interest on the capital, plus a 3 per cent sinking fund. If the consumption of power is more carefully examined now, the scheme will be found to pay a satisfactory net profit over the above charges against revenue.

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32. From the above figures, there is power capable of development and within reach of markets as follows :—

Number and division.	Continuous power.	At 40 per cent load factor.
1. Southern division	47,000	117,500
2. Madras-Nilgiri division	97,500	244,300
3. Northern division	60,600	151,300
4. West Coast division	26,000	65,000
Total ...	231,150	578,100

33. For the purpose of this report, I will confine myself to the Madras-Nilgiri division, and give an approximate estimate of a power supply system from the Nilgiris to Madras, and intermediate points, and to Calicut.

There are, however, two very important points which seriously affect the scheme, viz.,—

(1) the concession given for the development of the Kundah River project ;

(2) the licence given for a power supply in the town of Coimbatore and the Nilgiris district ;

(3) the concession given for the development of the Pykara project.

34. Fortunately, no licence has been given for the power from Pykara to be supplied to any place, although Calicut is mentioned in the concession. This concession is valueless unless a licence is given and I would recommend that under no consideration should a licence be given.

35. As to the Kundah river concession and Coimbatore licence, every effort should be made to secure their reversion to Government even to the extent of buying back the rights. The scheme will be a small one and consequently costly to develop and operate, making it necessary to charge high rates to the consumers which react unfavourably in other industrial centres. The rates charged by this small scheme will be different from those charged by the larger schemes serving other districts.

36. Its power supply will be guaranteed by only one power station, and therefore, more liable to interruption. This will also react unfavourably on the cosumption of hydro-electric power in other centres. Although the consumption of power in Coimbatore and the Nilgiris district will be relatively small, it is a very important item in the Government scheme. The transmission line from Pykara or Cholatipuzha will pass through Ootacamund and will require only about 25 miles extra length to pass through Coimbatore

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and thence to Erode, instead of direct to Erode. For this extra transmission line an additional load of approximately 6,000 horse-power will be obtained for the Government system.

37. The maximum delivered load in Bangalore is 5,200 E.H.P. and the revenue with the rates charged in the annexed schedule is just Rs. 11,50,000 per annum or in round figures Rs. 220 per maximum horse-power per annum. This would amount to a revenue of Rs. 13,20,000 per year in Coimbatore and is just the revenue required to make the Government scheme pay from the start. In other words, the Coimbatore Nilgiris supply district is of vital importance to the Government scheme from the start.

38. This revenue will be correspondingly higher if the rates are fixed higher than the Bangalore rates, but I am of the opinion that the rates for large blocks of power only should be increased and then only to ·8 of an anna per B.O.T.U. (K.W.H.) for blocks of more than 300 horse-power and graduated up to 2 annas per unit for small motor installations. The power is not worth any more and higher rates will only retard industrial development or will drive them out entirely, as actually occurred recently in the case of a prospective large power consumer who moved his mill from Madras to another city and got his power for much less than it would have cost him in Madras.

DESCRIPTION OF THE SCHEME.

39. The power station should be at Pykara, if possible, but if it is not possible to secure the rights, then the Cholatipuzha project should be developed.

40. The estimated cost of the power station given below will apply in either case as the more costly development has been provided for.

41. The transmission line, starting at Cholatipuzha will pass via Pykara through Ootacamund to Coimbatore and thence to Erode. From Erode the line would pass through Salem and thence generally follow the South Indian Railway to Madras, as shown on the attached map. The distance from the power station along this route is approximately 360 miles.

The line to Calicut will be 40 miles long and will generally follow the provincial road.

42. Provision has been made for receiving stations at Madras, Coimbatore and Calicut. A sub-station has been provided at Morapur in which will be installed synchronous condensers for line regulation. Provision will be made for a branch line out to

Mekadatu, a distance of approximately 60 miles, but the cost of this branch line has not been included in this estimate. No sectionalizing stations are required in the line to Calicut.

43. Two out-door sectionalizing stations have been provided for--one about half-way between Coimbatore and *Morapur* and the other about half-way between *Morapur and Madras.*

Estimates.

44. *Capital cost.*—The estimate for the generating station is on the basis of Cholatipuzha project No. 116, and will be equipped for generating 40,000 E.H.P. maximum demand at the high tension busses. The head is 2,250 feet and the water required will be 200 cusecs which at a load factor of 40 per cent is equivalent to a continuous flow of 80 cusecs. There will, therefore, have to be provided at the Penstock Head Gates a diurnal storage of—

$$80 \times 24 \times 3{,}600 = 6{,}912{,}000 \text{ cubic feet}$$

say 7,000,000 ,,

For safety sake this head gates storage should be as large as possible even up to the full storage necessary to carry through the low water season. Probably a storage of 1,000 million cubic feet would be sufficient; the exact amount can be obtained only by actual surveys and stream flow observations. This should be done during this hot weather.

45. *Power station.*—

		Rs.
(1)	Reservoir including reservoir dam, channels, forebay and head gates	17,50,000
(2)	Generating station building	4,50,000
(3)	Penstocks, 10,000 feet long, top 1/3, one pipe, 66″ diameter, middle 1/3, two pipes, 42″ diameter, and bottom 1/3, four pipes 30″ diameter, erected, complete with valves ...	27,00,000
(4)	Four 10,000 E.H.P. generators direct connected to 12,000 b.h.p. turbines, delivered and erected...	14,75,000
(5)	Two exciters and turbines delivered and erected.	1,50,000
(6)	Transformers, four banks of 15,000 K.V.A. each 150,000 volts, delivered and erected!... ...	11,00,000
(7)	All high and low tension switchgear delivered and erected	10,50,000
(8)	All other station equipment delivered and erected...	3,50,000
(9)	Staff quarters, storehouse and workshop ...	3,00,000
	Total, Power station ...	93,25,000

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46. *Transmission line.*—Double 3-phase circuits on steel towers 80 feet high, spaced six (6) to the mile, starting at Cholatipuzha.

Cost of one mile—

	Rs.
(1) Six miles stranded copper conductor weight per 1,000 feet, 653 lb.—21,000 lb. erected.	21,000
(2) Six towers 80 feet high erected each at Rs. 1,600	9,600
(3) Thirty-six strings of insulators, nine disks per string erected	5,400
(4) Overhead ground wire erected	1,000
(5) Telephone line	1,500
(6) Right of way and clearing	1,000
Cost of one mile ...	39,500
Distance Cholatipuzha to Madras 360 miles at Rs. 39,500 ...	1,42,20,000

47. *Receiving stations.*—

Madras for bulk supply only—

(1) Station building store-house and workshop.	3,00,000
(2) Transformers, two banks of 15,000 K.V.A. each	5,50,000
(3) Switchgear, high and low tension busses, lightning arresters, delivered and erected.	8,50,000
(4) One 10,000 K.V.A. synchronous condenser delivered and erected	1,80,000
(5) Other station equipment	2,00,000
(6) Distribution system to bulk consumers ...	5,00,000
Total ...	25,80,000

48. *Coimbatore for supply to the ultimate consumers.*—

(1) Station building, store-house and workshop	3,00,000
(2) One bank of 15,000 K.V.A. transformers (one transformer spare)	3,50,000
(3) Switchgear, high and low tension busses, lightning arresters	8,50,000
(4) One 10,000 K.V.A. synchronous condenser delivered and erected	1,80,000
(5) Other station equipment	2,00,000
(6) Distribution system to all consumers ...	6,50,000
Total ...	25,30,000

49. *Sub-station at Morapur for line regulation purposes.*—

	RS.
(1) Station building	1,00,000
(2) Staff quarters and store-house and work-shop	1,00,000
(3) One bank of 15,000 K.V.A. transformers delivered and erected (one transformer spare)	3,50,000
(4) Switchgear, high and low tension busses and lightning arresters erected... ...	5,00,000
(5) One 10,000 K.V.A. synchronous condenser erected	1,80,000
(6) All other station equipment	1,00,000
Total ...	13,30,000

50. *Two sectionalizing stations.*—

Outdoor type	2,00,000
Quarters for the transmission line inspection forces...	1,00,000
Total ...	3,00,000

51. Transmission line to Calicut to operate at 75,000 volts and using 60 feet wooden poles spaced 12 to the mile starting at Cholatipuzha :—

	RS.
Cost of one mile—	
1. Six-mile stranded conductor copper equivalent 320 lb. per 1,000 feet, 10,000 lb. erected ...	10,000
2. Twelve structures at Rs. 400	4,800
3. Seventy-two insulator strings, 4 disks per string...	3,750
4. Overhead ground wire	1,000
5. Telephone line	1,500
6. Right of way and clearing	1,000
Total for one mile ...	22,050
or say ...	22,000
Distance, Cholatipuzha to Calicut 40 miles × 22,000	8,80,000

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52. *Receiving station at Calicut for supply to all consumers.*—

	RS.
1. Station buildings, store-house and workshop.	3,00,000
2. One bank of 7,500 K.V.A. transformers (one spare transformer) 75,000/150,000 volts ...	2,00,000
3. Switchgear, lightning arresters, high and low tension busses	4,00,000
4. One 5,000 K.V.A. synchronous condenser ...	1,00,000
5. All other station equipment	2,00,000
6. Distribution system to all consumers ...	6,50,000
Total ...	18,50,000

53. Possible cost of—

New roads and repairs to old roads	2,50,000
Miscellaneous office buildings and store-houses not already provided for	50,000
Total ...	3,00,000

54. The total cost of the entire system is—

1. Generating station	93,25,000
2. Transmission line to Madras	1,42,20,000
3. Madras receiving station	25,80,000
4. Coimbatore receiving station	25,30,000
5. Sub-station at Morapur	13,30,000
6. Two sectionalizing stations	3,00,000
7. Transmission line to Calicut	8,80,000
8. Receiving station at Calicut	18,50,000
9. Roads	2,50,000
10. Miscellaneous buildings	50,000
11. Contingencies at 5 per cent	16,65,750
12. Special tools and plant at 5 per cent ...	16,65,750
13. Preliminary expenses	5,00,000
14. Salaries and establishment estimated at ...	10,00,000
Total ...	3,81,46,500
Add for rounding ...	53,500
Final total cost ...	3,82,00,000

55. The generating station should be designed so as to permit of extensions as may be required up to 80,000 E.H.P., on a 40 per cent load factor basis, that is, up to double the capacity now estimated for. The same applies to the receiving stations in Madras and Coimbatore. The transmission line, on account of the high voltage limitations of the size of conductor due to corona losses, will be capable of transmitting this larger amount of power without any modifications.

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56. The water required to generate 80,000 E.H.P., at a load factor of 40 per cent, is 40 per cent of 400 cusecs = 160 cusecs continuous flow and it will probably be found by stream flow observations throughout a year that a storage of 1,000 million cusecs, as is provided for above, will be very nearly sufficient and little extra storage will have to be provided.

57. *Revenue expenditure.*—

	RS.	RS.
(A) Operations and maintenance—		
(1) Administration	1,25,000	
Inspection section	75,000	
Upper subordinate civil engineering staff...	25,000	
Travelling allowance and miscellaneous office expenses	50,000	
Bonus to entire staff	75,000	
		3,50,000
(2) Generation		2,50,000
(3) Transmission, 400 miles at Rs. 500.		2,00,000
(4) Distribution—		
Madras	1,25,000	
Coimbatore	1,25,000	
Calicut	1,25,000	
Morapur	30,000	
		4,05,000
Total, Operation and maintenance.		12,05,000
(B) Interest at 6 per cent on Rs. 382 lakhs of capital		22,92,000
(C) Depreciation at 2 per cent on the total capital of Rs. 382 lakhs ...		7,64,000
(D) Sinking fund at 2·6 per cent of the total capital		9,93,200
(E) Sundries such as municipal taxes and water-rates, subsidies to patels along the transmission line, etc.		50,000
Total, Expenditure chargeable to revenue		53,04,200

58. *Item (B)—Interest.*—The period of construction will be four years and therefore the capital will be expended at the rate of Rs. 95·5 lakhs per annum and the interest payable thereon will be chargeable to the general revenues of the State and should not be added to the capital cost of the scheme. This, for the reason that the State expects to make a profit in future years and the loss due to interest on the capital in these years of construction should be set

attendant students' social activities. What is required for the Telugu students entering the new university is not merely the reduplication of courses and examinations but 'University life' which can only be obtained by the intimate and constant association of students with students and students with teachers and by the many-sided activities of an academic community which a unitary and residential university represents. Education imparted at isolated affiliated colleges is apt to make the examination dominate the whole educational course. The extent of the country which is roughly 83,000 square miles renders a single unitary Telugu university impracticable A scheme is therefore framed which will provide at present for the concentration of first-grade colleges in the Telugu country and which will at the same time aim at the ultimate development of these centres into separate units. This will ensure the coming together in large numbers of students and teachers and will give an opportunity for a real corporate and residential university life to develop, if not at one centre at least in two or three centres in the Andhra Desa. This view has been emphasized in the Bill by an insistence on the residential system at all centres and by the provision for the establishment of students' unions.

"But the special feature of the Andhra University scheme which explains as it were the position of the new university in relation to the economic and industrial life of the Telugu districts is a recognition of the need for a new correlation between the work of a provincial university and the industries of the country. While the older universities both in Europe and in India have been content to aim at high scholarship in literary and scientific subjects, the new universities in the west have been turning their attention towards specialization in various branches of technology. For example, the Universities of Manchester, Leeds, Sheffield, Liverpool and Glasgow have while retaining the ordinary university courses of study, specialised in particular branches of technology which bear a direct relationship to the special industries established in the districts adjacent to them. The need for the new Andhra University to set an example of what can be done by means of technical colleges to keep university education directly in touch with the industrial organization of a country has been recognized by the Government and all those who have been instrumental in promoting the scheme for the new university. This point was amplified at the Andhra University Conference held at Vizagapatam on the 22nd November 1922. One reason above all others for our belief in the immediate necessity for the establishment of technical and technological colleges is that taking a long view and looking ahead in the development of Indian industries and commerce, we believe that in the near future rapid progress of industrial concerns in India must take place and consequently the necessity for Indian skilled labour. In this respect the Andhra districts are favourably situated. Vizagapatam is developing into one of the foremost ports of India and also into a prominent railway centre. The opening up of the Raipur-Vizagapatam railway line will stimulate to an almost unknown extent the industries of the districts adjoining the Telugu country. There is already in the Telugu country a considerable mining industry. Paper, tanning and textile industries have just begun to work. There is agricultural and forest development and not a little coastal trade. Two important railways with big schemes for extension meet in the Telugu country. From the above it must be obvious that what has been done in the minor universities of England and what in a small

of factories and mills, not only in Madras City, but in all other towns to be served by the Government system. This fund will be mentioned later on in this report.

64. Twenty thousand horse power is only the beginning of the power requirements of a city with the population and industrial facilities of a city like Madras.

Consumption at the end of three years after start :

= 20,000 H.P. × 45 per cent L.F. × ·746 × 8,760 H = 58,800,000 B.O.T. units.

The average rate is taken at ·8 annas per B.O.T.U.

Then 58,800,000 at ·8 annas = Rs. 29,40,000 is the revenue in the third year after the start.

65. *Coimbatore.*—Here the situation is quite different from Madras and is identical with Bangalore, that is, the supply will be to the ultimate consumer and Government will get all the profit that the consumer pays and which the licensee, or middle man would get.

66. This estimate is based on a maximum demand of 6,000 E.H.P. The rates are based on 0·8 annas as the minimum at which power will be sold varying as per schedule up to 4 annas per unit for lighting. With the Bangalore rates the gross revenue per horse-power of maximum demand is :

$$\text{Rs.}\frac{11,50,000}{5,200} = \text{Rs. } 221$$

and with the rates proposed for Coimbatore, the rate would be Rs. 260 per horse power of maximum demand. Then 6,000 horse-power × 260 = Rs. 15,60,000 per year. This is the revenue that can be expected for the third year after the start.

67. *Calicut.*—The same remarks as for Coimbatore apply except that the load will be 2,000 horse-power maximum demand. Then 2,000 horse-power × Rs. 260 = Rs. 5,20,000—

TOTAL REVENUE.

	Rs.
Madras	29,40,000
Coimbatore	15,60,000
Calicut	5,20,000
Total ...	50,20,000

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68. The net financial results will be as follows :—

Year of operation. (1)	Capital cost. (2)	Horse-powers delivered. (3)	Horse-powers at generating station. (4)	Interest at 6 per cent salaries, wages and materials. (5)	Depreciation at 2 per cent for renewals. (6)
	LAKHS.				
First	382	9,300	9,500	35,47,000	..
Second	382	18,600	19,500	35,47,000	..
Third	382	28,000	30,800	35,47,000	..
Fourth	382	30,200	33,200	35,47,000	..
Fifth	382	32,600	36,000	35,47,000	..
Sixth	432	35,200	38,800	38,47,000	8,64,000
Seventh	432	38,000	41,800	38,47,000	8,64,000
Eighth	432	41,000	45,000	38,47,000	8,64,000
Ninth	432	44,300	48,700	38,47,000	8,64,000
Tenth	432	47,800	52,600	38,47,000	8,64,000

Year of operation.	Sinking fund at 2·6 per cent. (7)	Total working expenses. (8)	Gross receipts. (9)	Net receipts. (10)
First	9,93,200	45,40,200	16,73,000	— 28,67,200
Second	9,93,200	45,40,200	33,46,000	— 11,94,200
Third	9,93,200	45,40,200	50,20,000	4,79,800
Fourth	9,93,200	45,40,200	54,21,600	8,81,400
Fifth	9,93,200	45,40,200	58,55,000	13,15,800
Sixth	11,23,200	58,34,200	63,23,000	4,88,800
Seventh	11,23,200	58,34,200	68,29,000	9,94,800
Eighth	11,23,200	58,34,200	73,75,000	15,40,800
Ninth	11,23,200	58,34,200	79,65,000	21,30,800
Tenth	11,23,200	58,34,200	86,02,000	27,68,800

69. In the above table it is assumed that the load

in Madras will be 20,000 maximum E.H.P.
in Coimbatore „ 6,000 „ „
in Calicut „ 2,000 „ „

at the end of three years after the start of the power supply. This amounts to a maximum demand of 28,000 horse-power.

70. It is now necessary to forecast the annual increase in the maximum demand after the first three years' operation.

In Bangalore the actual increase in the power consumed is 200 per cent in eight years and the actual annual average increment is $14\frac{1}{2}$ per cent, refer to the attached curve sheet. In working up this annual growth in the power demand for the Punjab scheme, the

annual increment has been taken at 10 per cent which is less than the actual annual increment that has taken place in that province during the last ten years without any hydro-electric power supply.

The Madras load increment for five years ending 1922 has been 7·25 per cent in spite of the high rates charged for electric power. In making the revenue forecast, I have used an annual increment of 8 per cent for the years following the first three years of operation. In doing so, I would point out that this rate is bound to be exceeded and that when Government has once committed itself to a hydro-electric supply, they will be bound to meet any demands that may be made for power. Therefore, it is likely that extra capital will have to be invested in the scheme before the sixth year after the start of supply.

71. Contributions to the 2·6 per cent Sinking fund has been provided for in the forecast of annual charges against revenue and the whole capital will be retired during the 21st year of operation, on the basis of the fund being invested at 6 per cent compound interest.

72. Interest at 6 per cent on the total capital has been charged against revenue from the first year of operation.

73 A Depreciation fund of 2 per cent has been provided in the charges against revenue during and after the sixth year of operation. This Depreciation fund should be invested and the interest therefrom credited to revenue. This fund should be available for renewals, whenever necessary, but it is assumed there will be no renewals during the first five years.

74. During the fifth year of operation, it will be necessary to add to the generating station two 10,000 E.H.P. units at a cost of Rs. 50 lakhs for the necessary penstocks, turbines, generators, switchgear and station building. This additional penstock will be so arranged that, when necessary, a third installation of two 10,000 E.H.P. units can be installed and served therefrom, bringing the installed capacity up to 80,000 E.H.P. maximum, operating at a cost of 50 per cent load factor equivalent to 40,000 E.H.P. continuous which is taken as the ultimate development for which there will be sufficient water at Cholatipuzha.

75. A Mill Conversion fund of Rs. 10,00,000 should be set aside under Industries and administered by the Electrical department. This fund is for making loans to millowners for use in converting their mills to the electric drive and should bear interest at 6 per cent per annum and repayable in six half-yearly payments, the first payment to be made six months after the start of electric

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power supply to the mill. This fund will prove an extra guarantee that the rate of industrial development will be equal to or greater than that provided for in the above financial forecast.

76. I have not dealt with the other power divisions referred to above, as the information available is insufficient for the preparation of an estimate similar to that given above for the Madras-Nilgiris division. Further complete investigations will no doubt show that conditions are as favourable as in the Madras-Nilgiris division, but probably on a smaller scale.

For these investigations, a separate section of the Public Works Department should be constituted with the necessary staff for making a complete hydro-power survey, beginning with those projects mentioned above. All these projects should be completely surveyed and the detailed scheme worked out in each case.

77. At the same time, a complete survey of the power consuming capacity of the districts to be served by these projects should be made, preferably by this same section of the Public Works Department.

78. For this purpose, the services of fully qualified and experienced Hydro-electric Power Supply Engineers should be secured after the preliminary surveys have been completed by the regular staff of the Public Works Department. These preliminary investigations in the Madras-Nilgiris division have reached such a stage that if Government propose going ahead with this scheme, it is now necessary to secure the services of Hydro-electric Power Supply Engineers who have had broad experience in such work.

79. The route of the transmission line has been selected so as to readily serve the railways when electrification is decided on. When this is done, the supply of electric power to small towns and rural areas can most readily be done and this is a factor to be taken into consideration in deciding on railway electrification.

80. The industrial situation in the Madras Presidency is due solely to the high cost of power where it is available at all, or to the entire absence of power in large areas. Just as the building of railways developed the country, so also will an adequate supply of power, carry on the start made by the railways. There is no power available now and there is therefore no demand for power. If power is made available the demand will arise and the history of hydro-electric power in Bangalore and Mysore cities will repeat itself.

BANGALORE,
3rd April 1924.

S. G. FORBES.

[20th August 1925

C. P. S. No. 116 (*b*)]

Schedule of Rates.

Schedule of revised rates for the supply of electric power for lighting, heating, cooking and industrial purposes in the cities of Mysore and Bangalore and the Civil and Military Station of Bangalore, or wherever supplied.

For the supply of power for lighting.

	Rate per B.O.T.U.	Minimum monthly charge.
Lighting—		
Including small household appliances	4·0 annas	As. 9 per point of 60 watts per month.

Meter hire.

	Rs.	A.	P.	
For installation of 15 points or less	0	8	0	per month.
„ of 16 and over	1	0	0	„

Discounts.

Units per month.		Units per month.		
To consumers using 500 and	not exceeding	1,000	at the rate of	5 per cent.
„ above 1,000	„	2,000	„	10 „
„ „ 2,000	„	3,000	„	15 „
„ „ 3,000	„	4,000	„	20 „
„ using 4,000 and above	...	...	„	25 „

For the supply of power for cooking and heating.

For cooking and heating units of a larger capacity than 20 points maximum demand—

	Rates per B.O.T.U.	Minimum monthly charge.
	As.	Rs.
First 150 B.O.T.U. of consumption	1·0	8
Second 150 „ or fraction thereof ...	·75	8
All B.O.T.U. above 300	·5	8

Meter hire.—Rupee one per month will be charged for each meter installed for heating service.

Note.—The above schedule is subject to the following conditions :—

(1) That the customer at his or her own cost installs the necessary circuit or circuits complete with regularly specified safety devices and switches to admit of operation of such heating appliances being entirely independent of the recording meter installed for lighting purposes.

(2) That current for electric light is not, under any circumstances, taken from the supply mains, feeders or wiring appliances installed for the operation of electric heating appliances.

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For the supply of power for industrial purposes.

	Rates per B.O.T.U.	Minimum monthly charge per rated H.P. maximum demand.
	AS	
Rated maximum demand in electrical H.P.—		
Up to 20 H.P. inclusive	2	No minimum.
21 H.P. and up to 50 H.P. inclusive.	1·5	,,
51 ,, 100 ,,	·95	50 per cent load factor.
101 ,, 200 ,,	·80	,,
201 ,, 300 ,,	·70	,,

All large consumers have long-term agreements effected before the 0·6 anna rate went into effect and are therefore paying only one-half (0·5) anna per unit.

NOTE.—The above rates will apply when the proposed installation is within a reasonable distance of the department's power supply lines. When such is not the case, the special terms will be arranged to suit such special cases, such as when the proposed installation is outside the Municipal limits.

The load factor will be calculated as under :—

$$\text{Load factor} = \frac{\text{Total B.O.T.U consumed during the month.}}{\text{working days} \times 12 \text{ hrs.} \times \text{rated H.P.} \times \cdot 746.}$$

The minimum monthly charge will be half rated H.P. × 12 × number of working days in the month × ·746.

NOTE.—(1) Installations exceeding an integral number of H.P. shall be rated at the next lower integral. All installations are subject to inspection and test by qualified inspectors of the Electrical Department and re-ratings for excess demands will be made whenever necessary.

(2) A fixed charge of Rs. 2 per month will be levied as meter hire for each meter installed.

(3) All installations above 20 H.P. will be supplied with electric power under a contract, the terms and conditions of which should be obtained from the Chief Electrical Engineer to the Government of Mysore.

(4) In special cases power will be supplied at single phase, 60 cycles and 110 or 220 volts, for all installations up to and including 3 H.P., the charge for the power being the same as for small motors and under special conditions.

(5) With the above exception, the power will be supplied at 3 phase, 25 cycles and 220 volts for all installations up to and including 50 H.P. All installations of above 50 H.P. will be supplied at 3 phase, 25 cycles and 2,200 volts.

Important.

(1) Intending consumers are advised to consult the Superintendent, Bangalore Power and Lighting, before incurring expenses for installing lights, fans, etc. Application for services should be made on authorized forms obtainable from the Superintendent, Bangalore Power and Lighting.

(2) Consumers wishing to discontinue the use of electrical supply are requested to notify the Superintendent, Bangalore Power and Lighting, and to give their future address to facilitate correspondence.